

CHAPTER I - OPERATIONAL PROCEDURES

1. GENERAL

The Joint Typhoon Warning Center (JTWC) provides a variety of routine services to the organizations within its area of responsibility, including:

a. Significant Tropical Weather Advisories: issued daily, these products describe all tropical disturbances and assess their potential for further development during the advisory period;

b. Tropical Cyclone Formation Alerts: issued when synoptic, satellite and/or aircraft reconnaissance data indicate development of a significant tropical cyclone in a specified area is likely;

c. Tropical Cyclone Warnings: issued periodically throughout each day for significant tropical cyclones, giving forecasts of position and intensity of the system; and

d. Prognostic Reasoning Messages: issued twice daily for tropical storms and typhoons in the western North Pacific; these messages discuss the rationale behind the most recent JTWC warnings.

The recipients of the services of JTWC essentially determine the content of JTWC's products according to their ever changing requirements. Therefore, the spectrum of routine services is subject to change from year to year. Such changes are usually the result of deliberations held at the Annual Tropical Cyclone Conference.

2. DATA SOURCES

a. COMPUTER PRODUCTS:

A standard array of synoptic-scale computer analyses and prognostic charts are available from the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) at Monterey, California. These products are provided to JTWC via the Naval Environmental Data Network (NEDN).

b. CONVENTIONAL DATA:

This data set is comprised of land-based and shipboard surface and upper-air observations taken at, or near, synoptic times, cloud-motion winds derived twice daily from satellite data, and enroute meteorological observations from commercial and military aircraft (AIREPS) within six hours of synoptic times. Conventional data charts are prepared daily at 0000Z and 1200Z using computer- and hand-plotted data for the surface/gradient and 200 mb (upper-tropospheric) levels. In addition to these analyses, charts at the 925, 850, 700, 500 and 400 mb levels are computer-plotted from rawinsonde/pibal observations at the 12-hour synoptic times.

c. AIRCRAFT RECONNAISSANCE:

Data provided by aircraft weather reconnaissance are invaluable for locating the position of the center of developing systems and essential for the accurate determination of:

- maximum surface and flight-level wind
- minimum sea-level pressure
- horizontal surface and flight-level wind distribution
- eye/center temperature and dew point

In addition, wind and pressure-height data at the 500 and/or 400 mb levels, provided by the aircraft while enroute to, or from fix missions, or during dedicated synoptic-scale flights, provide a valuable supplement to the all too sparse data fields of JTWC's area of responsibility. A more detailed discussion of aircraft weather reconnaissance is presented in Chapter II.

d. SATELLITE RECONNAISSANCE:

Meteorological satellite data obtained from the Defense Meteorological Satellite Program (DMSP) and National Oceanic and Atmospheric Administration (NOAA) spacecraft played a major role in the early

detection and tracking of tropical cyclones in 1987. A discussion of the role of these programs is presented in Chapter II.

e. RADAR RECONNAISSANCE:

During 1987, as in previous years, land-based radar coverage was utilized extensively when available. Once a tropical cyclone moved within the range of land-based radar sites, their reports were essential for determination of small-scale movement. Use of radar reports during 1987 is discussed in Chapter II.

f. DRIFTING METEOROLOGICAL BUOYS:

JTWC received wind speed, sea-level pressure, sea surface temperature and air temperature reports from six drifting meteorological buoys deployed by the U. S. Navy beginning in the middle of June 1987. One line of three buoys was deployed along 7 degrees North Latitude from south of Guam eastward toward the Marshall Islands. Another set of three was deployed along 11 degrees North Latitude from southwest of Guam eastward through the Caroline Islands. The buoys performed flawlessly throughout most of the western North Pacific tropical cyclone season. At the end of the year, four buoys continued to operate, one no longer transmitted data and another was apparently taken to Tandag City, Mindanao, R.P., where it continued to transmit. The three northernmost buoys tracked basically westward and covered 25 to 35 degrees of longitude. The southern buoys drifted more slowly and erratically. One buoy either snagged its drouge on a submerged reef east of Woleai Atoll or became trapped in an eddy within the island/reef chain.

JTWC received at least one position update from each buoy per day and up to eight meteorological data updates per buoy per day. Buoy data were consistent with the data from other conventional sources to the extent that they was considered to be, in most cases, more reliable and more accurate than ship reports and some island reporting stations. As a backup and position check, JTWC also received buoy data, on a delay basis, over the AWN (Manop header SSVX6 LFPW).

An expanded buoy network for the 1988 tropical cyclone season is being planned.

a. JTWC currently has access to three primary communications circuits.

3. COMMUNICATIONS

(1) The Automated Digital Network (AUTODIN) is used for dissemination of warnings, alerts and other related bulletins to Department of Defense installations. These messages are relayed for further transmission over U.S. Navy Fleet Broadcasts, and U.S. Coast Guard CW (continuous wave Morse Code) and voice broadcasts. Inbound message traffic for JTWC is received via AUTODIN addressed to NAVOCEANCOMCEN GQ or DET 1, 1WW NIMITZ HILL GQ.

(2) The Air Force Automated Weather Network (AWN) provides weather data to JTWC through a dedicated circuit from the Automated Digital Weather Switch (ADWS) at Hickam AFB, Hawaii. The ADWS selects and routes the large volume meteorological reports necessary to satisfy JTWC requirements for the right data at the right time. Weather bulletins prepared by JTWC are inserted into the AWN circuit via the Naval Environmental Display Station (NEDS) through the Nimitz Hill Naval Telecommunications Center (NTCC) of the Naval Communications Area Master Station Western Pacific.

(3) The Naval Environmental Data Network (NEDN) is the communications link with the computers at FLENUMOCEANCEN. JTWC is able to receive environmental data from FLENUMOCEANCEN and provide data directly to the computers to execute numerical techniques.

b. NEDS has been the backbone of the JTWC communications system for several years. Currently, JTWC is undergoing an upgrade that will make use of microcomputer technology and automate much of the work that goes into message preparation and transmission. This will decrease the work load on the NEDS and allow JTWC to interface directly with NTCC for AWN and AUTODIN messages.

4. ANALYSES

A composite surface/gradient-level (3000 ft (914 m)) manual analysis of the JTWC area of responsibility is accomplished daily on the 0000Z and 1200Z conventional data. Analysis of the wind field using streamlines is stressed for tropical and subtropical regions. Analysis of the pressure field outside the tropics is accomplished routinely by the Naval Oceanography Command Center Operations watch team and is used by JTWC in conjunction with their analysis of the tropical wind fields.

A composite upper-tropospheric manual streamline analysis is accomplished daily utilizing rawinsonde data from 300 mb through 100 mb, winds obtained from satellite-derived cloud motion analysis, and AIREPS (taken plus or minus three hours of chart valid time) at or above 31,000 feet (9,449m). Wind and height data are used to generate a representative analysis of tropical cyclone outflow patterns, mid-latitude steering currents, and features that may influence tropical cyclone intensity. All charts are hand-plotted in the tropics to provide all available data as soon as possible to the Typhoon Duty Officer (TDO). These charts are augmented by computer-plotted charts for the final analysis.

Computer-plotted charts for the 925, 850, 700, 500 and 400 mb levels are available for streamline and/or height-change analysis from the 0000Z and 1200Z data base. Additional sectional charts at intermediate synoptic times and auxiliary charts, such as station-time plot diagrams and pressure-change charts, are also analyzed during periods of significant tropical cyclone activity.

5. FORECAST AIDS

The following objective techniques were employed in tropical cyclone forecasting during 1987 (a description of these techniques is presented in Chapter V):

a. MOVEMENT

- (1) 12-HOUR EXTRAPOLATION
- (2) CLIMATOLOGY
- (3) COSMOS (Model Output Statistics)
- (4) CSUM (Colorado State University Model)
- (5) OTCM (Dynamic Model)
- (6) TAPT (Empirical)
- (7) HPAC (Half Persistence - Half Climatology Blend)
- (8) TYAN78 (Analog)

b. INTENSITY

- (1) CLIMATOLOGY
- (2) DVORAK (Empirical)
- (3) THETA -E (Empirical)

c. WIND RADIUS (Analytical)

6. FORECAST PROCEDURES

a. INITIAL POSITIONING

The warning position is the best estimate of the center of the surface circulation at synoptic time. It is estimated from an analysis of all fix information received up to one and one-half hours after synoptic time. This analysis is based on a semi-objective weighting of fix information based on the historical accuracy of the fix platform and the meteorological features used for the fix. The interpolated warning position reduces the weighting of any single fix and results in a more consistent movement and a warning position that is more representative of the larger-scale circulation. If the fix data are not available due to reconnaissance platform malfunction or communication problems, synoptic data or extrapolation from previous fixes are used.

b. TRACK FORECASTING

A preliminary forecast track is developed based on an evaluation of the rationale behind the previous warning and the guidance given by the most recent set of objective techniques and numerical prognoses. This preliminary track is then subjectively modified based on the following considerations:

(1) The prospects for recurvature or erratic movement are evaluated. This determination is based primarily on the present and forecast positions and amplitudes of the middle-tropospheric, mid-latitude troughs and ridges as depicted on the latest upper-air analysis and numerical forecasts.

(2) Determination of the best steering level is partly influenced by the maturity and vertical extent of the tropical cyclone. For mature tropical cyclones located south of the subtropical ridge axis, forecast changes in speed of movement are closely correlated with anticipated changes in the intensity or relative position of the ridge. When steering currents are relatively weak, the tendency for tropical cyclones to move northward due to internal forces is an important consideration.

(3) Over the 12- to 72-hour (12- to 48-hour in the southern hemisphere) forecast period, speed of movement during the early forecast period is usually biased towards persistence, while the later forecast periods are biased towards objective techniques. When a tropical cyclone moves poleward, and toward the mid-latitude steering currents, speed of movement becomes increasingly more biased toward a selective group of objective techniques capable of estimating acceleration.

(4) The proximity of the tropical cyclone to other tropical cyclones is closely evaluated to determine if there is a possibility of binary interaction.

A final check is made against climatology to determine whether the forecast track is reasonable. If the forecast deviates greatly from one of the climatological tracks, the forecast rationale may be reappraised.

c. INTENSITY FORECASTING

For this parameter, heavy reliance is placed on intensity trends from aircraft reconnaissance reports when available, wind and pressure data from ships and land stations in the vicinity of the tropical cyclone, the Dvorak satellite empirical model and climatology. An evaluation of the entire synoptic situation is made, including the location of major troughs and ridges, the position and intensity of any nearby tropical upper-tropospheric troughs (TUTTs), the vertical and horizontal extent of the tropical cyclone's circulation and the extent of the associated upper-level outflow pattern. An essential element affecting each intensity forecast is the accompanying forecast track and the environmental influences along that track, such as terrain, vertical wind shear, and the existence of an extratropical environment.

d. WIND RADII FORECASTING

Once the forecast intensities have been derived, the horizontal distribution of surface winds (winds greater than 30-, 50-, and 100-kt) is determined. The most recent wind radii and associated asymmetries are deduced from all available surface wind observations and reconnaissance aircraft reports. Based on the current surface wind distribution, preliminary estimates of future wind radii are provided by an empirically derived objective technique (Holland, 1980). These estimates may be subjectively modified based upon the anticipated interaction of the tropical cyclone's circulation with forecast locations of large-scale wind regimes and significant land masses. Other factors including the tropical cyclone's speed of movement and possible extratropical transition are also considered.

7. WARNINGS

Tropical cyclone warnings are issued when a closed circulation is evident and maximum sustained winds are forecast to increase to 34 kt (18 m/sec) within 48-hours, or if the tropical cyclone is in such a position that life or property may be endangered within 72-hours. Warnings may also be issued in other situations if it is determined that there is a need

to alert military or civil interests to threatening tropical weather conditions.

Each tropical cyclone warning is numbered sequentially and includes the following information: the position of the surface center; estimate of the position accuracy and the supporting reconnaissance (fix) platforms; the direction and speed of movement during the past six hours (past 12-hours in the southern hemisphere); the intensity and radial extent of over 30-, 50-, and 100-knot surface winds, when applicable. At forecast intervals of 12-, 24-, 48-, and 72-hours (12-, 24-, and 48-hours in the southern hemisphere), information on the tropical cyclone's anticipated position, intensity and wind radii are also provided. Vectors indicating the mean direction and mean speed between forecast positions are also included in all warnings.

Warnings in the western North Pacific and North Indian Oceans are issued every six hours valid at standard times; 0000Z, 0600Z, 1200Z and 1800Z (every 12-hours; 0000Z, 1200Z or 0600Z, 1800Z in the southern hemisphere). All warnings are released to the communications network no earlier than synoptic time and no later than synoptic time plus two and one-half hours so that recipients will have a reasonable expectation of having all warnings "in hand" by synoptic time plus three hours (0300Z, 0900Z, 1500Z and 2100Z).

Warning forecast positions are later verified against the corresponding "best track" positions (obtained during detailed post-storm analysis to determine the actual path and intensity of the cyclone). A summary of the verification results for 1987 is present in Chapter V.

8. PROGNOSTIC REASONING MESSAGES

For tropical storms and typhoons in the western North Pacific Ocean, prognostic reasoning messages are transmitted following the 0000Z and 1200Z warnings, or whenever the previous forecast reasoning is no longer valid. This plain language message is intended to provide meteorologists with the reasoning behind the latest forecast.

In addition to this message, prognostic reasoning information applicable to all customers is provided in the remarks section of warnings when significant forecast changes are made or when deemed appropriate by the TDO.

9. TROPICAL CYCLONE FORMATION ALERTS

Tropical Cyclone Formation Alerts (TCFAs) are issued whenever interpretation of satellite imagery and other meteorological data indicate that the formation of a significant tropical cyclone is likely. These formation alerts will specify a valid period not to exceed twenty-four hours and must either be cancelled, reissued, or superseded by a tropical cyclone warning prior to the expiration of the valid time.

10. SIGNIFICANT TROPICAL WEATHER ADVISORIES

This product contains a general, non-technical description of all tropical disturbances in JTWC's area of responsibility (AOR) and an assessment of their potential for further (tropical cyclone) development. In addition, all tropical cyclones in warning status are briefly discussed. Two separate messages are issued daily and are valid for a 24-hour period. The Significant Tropical Weather Advisory for the western Pacific Ocean (ABPW PGTW) covers the area east of 100 degrees East Longitude to the dateline and is issued by 0600Z. The Significant Tropical Weather Advisory for the Indian Ocean (ABIO PGTW) covers the area west of 100 degrees East Longitude to the coast of Africa and is issued by 1800Z. It is reissued whenever the situation warrants. For each suspect area, the words "poor", "fair", and "good" are used to describe the potential for development. "Poor" will be used to describe a tropical disturbance in which meteorological conditions are currently unfavorable for development; "fair" will be used to describe a tropical disturbance in which the meteorological conditions are favorable for development but significant development has not commenced; and "good" will be used to describe the potential for development of a tropical disturbance covered by a TCFA.